1981

CTIONS OF FIRE BEHAVIOR AND TANCE TO CONTROL

WITH PHOTO SERIES
SIERRA MIXED CONIFER TYPE
SIERRA TRUE FIR TYPE

FRANKLIN R. WARD
DAVID V. SANDBERG

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ANKLIN R. WARD is a forestry technician at the Pacific Northwest Forest and
nge Experiment Station, Portland, Oregon. DAVID V. SANDBERG is a research
rester at the Pacific Northwest Forest and Range Experiment Station, Seattle,
shington.

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bstract

is publication presents tables on the behavior of fire and the resistance of els to control. The information is to be used with the photos in the publi- tion, "Photo Series for Quantifying Forest Residues in the Sierra Mixed nifer Type, Sierra True Fir Type" (USDA For. Serv. Gen. Tech. Rep. PNW-95, 79, by Wayne G. Maxwell and Franklin R. Ward).

YWORDS: Fire behavior (forest), fire management, fire spread.

etric Conversion

To change	to	multiply by:
les per hour	kilometers per hour	1.6093
ains	meters	20.12
et	meters	0.3048
res	hectares	0.4047

pecies List

uglas-fir	Pseudotsuga menziesii (Mirb.) Franco
r	Abies spp.
nderosa pine	Pinus ponderosa Dougl. ex Laws.

Timber harvest and silvicultural practices--as well as natural phenomena, such as windthrow, ice damage, and wildfire--often leave undesirable amounts of forest residues. The forest manager must set limits on the amount of residues and fire hazard that are consistent with resource management objectives.

Photo series have been published as an inventory tool to assess fuel loadings by size class in several forest types. The photos are used to translate visual images to quantities (tons per acre) so the manager can describe the residue that should be retained to meet environmental concerns and goals of a particular specialty. The photos also provide a starting point for assessing fire hazard.

This publication presents tables for predicting rate of fire spread, flame length, and resistance of fuel to control for each residue condition depicted by the photo series for the Sierra mixed conifer and Sierra true fir types (Maxwell and Ward 1979). Fire behavior estimates are based solely on measured fuel loadings in the 1/4- to 3-inch diameter range. All other inputs to a mathematical fire spread model (Rothermel 1972), including depth of fuel bed and 1-hour timelag (0- to 1/4-inch diameter) loading, are generated by assuming similarity of the fuel bed to a stylized fuel model. Packing and surface-to-volume ratios were derived by interpolation between models. Foliage and litter loadings are reflected in the 1-hour timelag fuel loading. No live or coarse (greater than 3-inch diameter) fuels are considered.

o sets of fuel models are in widespread use for fire planning and hazard
praisal--Northern Forest Fire Laboratory (NFFL) and National Fire-Danger Rating
FDR) models. The NFFL models (Albini 1976) are also used for forecasting
navior of wildfire. Generally, the slash fuel models reflect an average of
pical fuel conditions in Douglas-fir and ponderosa pine slash. The NFDR models
eeming et al. 1977) differ from the NFFL series mainly in that a greater
pportion of 1-hour timelag fuels are present relative to 10- and 100-hour fuels
/4 inch to 3 inches). Packing ratios are similar, but NFFL models have more
arly optimum packing. Because of these differences, predictions for spread and
tensity of fire for fuels with properties of the NFDR slash models will be
ghtly greater at low windspeeds--and much greater at high windspeeds--than
els with the physical properties of NFFL slash models.

choice between using the NFFL or NFDR series of models to represent the fuel
d in a photo from Maxwell and Ward (1979) was based on the proportion of fine
els present and on the believability of the output on fire behavior. Residues
om second-growth timber and red slash, because of a greater amount of 1-hour
el loading, are better represented by NFDR models. Old-growth or overwintered
ash has characteristics similar to NFFL models.

hermel's (1972) fire spread model is the basis for estimates of fire behavior.
e algorithm used to estimate flame lengths for photographs judged similar to
DR fuel models is the same used in the NFDR system. The fire spread model,
wever, depends on a continuous and homogeneous fuel bed, and adjustments are
eded if those conditions do not prevail. Several fuel beds depicted in the
oto series by Maxwell and Ward (1979) were treated by fire or mechanical
ashing. Where a treatment drastically reduced depth or continuity of the fuel
d, outputs of the model were adjusted accordingly.

Tables 1-30 provide a means to quantify relative differences in fire potential between fuel beds in a manner consistent with, but more precisely than, stylized fuel models. The user should not expect predicted values to be exact estimates of fire behavior on an actual fire on a specific unit. Deviations from one-half to two times the predicted values can be expected. Even values one-fourth to four times the actual value may occur. Deviations are also possible if the fuel inventory is inaccurate or if the character of the fuel bed is substantially different from the stylized fuel model.

Spread of fire is amplified by wind and slope. Effective wind (Albini 1976) is the windspeed that alone would produce the same amplification as the combined effects of wind and slope. The tables show effective wind at midflame height. Figure 1 can be used to determine effective midflame windspeed.

Fuel moisture content is calculated by combining the three fine fuel classes so that:

Moisture content = 0.76 x (1-hour timelag moisture)
+0.18 x (10-hour timelag moisture)
+0.06 x (100-hour timelag moisture).

Fire perimeter, area, and resistance to control are also useful for fire planning. Formula and graphic aids (Fire Behavior Officer's Field Reference[1]) for determining perimeter and area are presented in appendix 1. Fuel resistance to control rating, slope, and flame length adjustment factors, and

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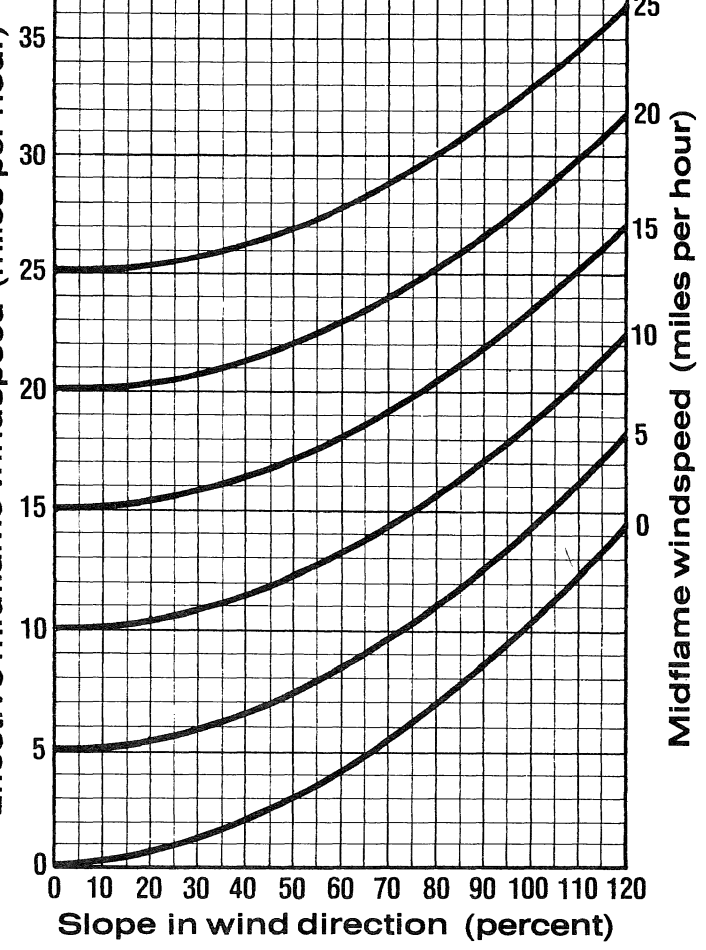
[1]National Interagency Fire Training Center, Marana, Arizona, 1978.



effective windspeed from midflame windspeed and ground slope in direction of wind.

onversion of resistance to control rating values to chains per hour of line
onstructed by one person are presented in appendix 2.

or the approximate potential fire behavior and resistance of fuel to control for
particular area and given weather conditions, determine the following:

. Which photo nearly matches, or which photos bracket, the area.
. Rate of spread of fire and flame length (tables 1-30).
. Perimeter and area of fire (from graphs and formulas in appendix 1).
. Resistance of fuel to control (from tables in appendix 2).

or example, if the area was represented by photo 2-MC-4-RC in Maxwell and Ward
1979) and there was a 5-mi/h wind at midflame height, a fine fuel moisture of
percent, and the area was on a 20-percent slope, the following conditions would
xist:

Effective midflame wind (miles per hour)--6
Rate of spread (chains per hour)--10
Flame length (feet)--6
Perimeter growth at 1 hour (chains)--29.3
Area at 1 hour (acres)--5.2
Resistance to suppression (chains/person-hour)--1.2

f the area was bracketed by two photos, interpolate by using the respective
ables.

terature Cited

bini, Frank A.
1976. Estimating wildfire behavior and effects. USDA For. Serv. Gen. Tech. Rep. INT-30, 92 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

eming, John E., Robert E. Burgan, and Jack D. Cohen.
1977. The National Fire-Danger Rating System--1978. USDA For. Serv. Gen. Tech. Rep. INT-39, 63 p., illus. Intermt. For. and Range Exp. Stn., Ogden, Utah.

xwell, Wayne G., and Franklin R. Ward.
1979. Photo series for quantifying forest residues in the: Sierra mixed conifer type, Sierra true fir type. USDA For. Serv. Gen. Tech. Rep. PNW-95, 79 p., illus. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

thermel, Richard C.
1972. A mathematical model for predicting fire spread in wildland fuels. USDA For. Serv. Res. Pap. INT-115, 40 p., illus. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Mixed Conifer

Size Class 4

Regeneration Cut

Tables 1 through 3

(Corresponds to Photo Series 1-MC-4-RC to 3-MC-4-RC in Maxwell and Ward 1979)

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BLE 2--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-MC-4-RC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

DEL DISTURE	RATE OF SPREAD									FLAME LENGTH									
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)									
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET									
2	1	4	8	13	17	22	27	35	48	2	4	5	7	8	9	9	11	12
3	1	4	7	11	15	19	23	30	41	2	4	5	6	7	8	8	9	11
4	1	3	6	10	13	17	21	26	37	2	3	4	5	6	7	8	8	10
5	1	3	6	9	12	15	19	24	33	2	3	4	5	6	6	7	8	9
6	1	3	5	8	11	14	17	22	31	1	3	4	5	5	6	7	8	9
7	1	3	5	8	11	14	17	21	29	1	3	4	5	5	6	6	7	8
8	1	3	5	7	10	13	16	20	28	1	3	4	4	5	6	6	7	8
9	1	2	5	7	10	12	15	19	27	1	3	4	4	5	6	6	7	8
10	1	2	4	7	9	12	14	18	25	1	3	3	4	5	5	6	7	8
11	0	2	4	6	8	11	13	17	23	1	2	3	4	5	5	6	6	7
12	0	2	4	5	7	10	12	15	21	1	2	3	4	4	5	5	6	7
13	0	2	3	5	6	8	10	13	17	1	2	3	3	4	4	4	5	6
14	0	1	2	3	5	6	7	9	13	1	1	2	2	3	3	3	4	4
15	0	1	1	2	3	4	4	6	8	0	1	1	2	2	2	2	2	3
16	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1

(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	9	12	15	19	24	34	1	3	4	4	5	6	6	7	8
3	1	3	5	8	10	13	16	21	29	1	2	3	4	4	5	5	6	7
4	0	2	4	7	9	12	14	18	25	1	2	3	3	4	4	5	6	6
5	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	5	5	6
6	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	4	5	6
7	0	2	4	5	7	10	12	15	21	1	2	2	3	3	4	4	5	6
8	0	2	3	5	7	9	11	14	20	1	2	2	3	3	4	4	5	5
9	0	2	3	5	7	9	10	13	19	1	2	2	3	3	4	4	4	5
10	0	1	3	4	6	8	10	12	17	1	2	2	3	3	3	4	4	5
11	0	1	3	4	5	7	8	11	15	1	1	2	2	3	3	3	4	4
12	0	1	2	3	4	5	7	9	12	1	1	2	2	2	3	3	3	4
13	0	1	1	2	3	4	5	6	8	0	1	1	1	2	2	2	2	3
14	0	0	1	1	1	1	2	2	3	0	0	0	1	1	1	1	1	1

Mixed Conifer

Size Class 4

Partial Cut

Tables 4 Through 11

(Corresponds to Photo Series 1-MC-4-PC to 8-MC-4-PC in Maxwell and Ward 1979)

TABLE 4--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-MC-4-PC (RATE OF SPREAD ESTIMATES ARE ONE-HALF OF NFFL CONTINUOUS SLASH MODEL)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)							
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14
PERCENT	CHAINS PER HOUR									FEET							
2	0	1	2	3	5	6	7	9	13	1	1	2	2	3	3	3	3
3	0	1	2	3	4	5	6	8	11	1	1	2	2	2	2	3	3
4	0	1	2	3	3	4	5	7	10	1	1	1	2	2	2	2	3
5	0	1	2	2	3	4	5	6	9	0	1	1	2	2	2	2	3
6	0	1	1	2	3	4	5	6	8	0	1	1	2	2	2	2	3
7	0	1	1	2	3	4	4	6	8	0	1	1	2	2	2	2	2
8	0	1	1	2	3	3	4	5	7	0	1	1	1	2	2	2	2
9	0	1	1	2	2	3	4	5	7	0	1	1	1	2	2	2	2
10	0	1	1	2	2	3	3	4	6	0	1	1	1	1	2	2	2
11	0	0	1	1	2	2	3	4	5	0	1	1	1	1	1	2	2
12	0	0	1	1	1	2	2	3	4	0	0	1	1	1	1	1	1
13	0	0	0	0	1	1	1	1	2	0	0	0	0	1	1	1	1

TABLE 5--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-MC-4-PC
(RATE OF SPREAD ESTIMATES ARE ONE-HALF OF NFFL CONTINUOUS SLASH MODEL)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	2	3	5	7	9	11	14	20	1	2	3	4	4	5	5	6	7
3	0	1	3	4	6	8	9	12	17	1	2	3	3	4	4	5	5	6
4	0	1	3	4	5	7	8	11	15	1	2	2	3	3	4	4	5	5
5	0	1	2	4	5	6	8	10	14	1	2	2	3	3	4	4	4	5
6	0	1	2	3	5	6	7	9	13	1	2	2	3	3	3	4	4	5
7	0	1	2	3	4	6	7	9	12	1	2	2	3	3	3	4	4	5
8	0	1	2	3	4	5	6	8	11	1	2	2	2	3	3	4	4	5
9	0	1	2	3	4	5	6	8	11	1	1	2	2	3	3	3	4	4
10	0	1	2	3	4	5	6	7	10	1	1	2	2	3	3	3	4	4
11	0	1	2	2	3	4	5	6	9	1	1	2	2	2	3	3	3	4
12	0	1	1	2	3	3	4	5	8	1	1	1	2	2	2	3	3	3
13	0	1	1	2	2	3	3	4	6	0	1	1	1	2	2	2	2	3
14	0	0	1	1	1	2	2	2	3	0	1	1	1	1	1	1	1	2
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BLE 7--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 4-MC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

EL ISTURE	RATE OF SPREAD									FLAME LENGTH								
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	1	3	6	10	13	17	21	27	37	1	3	4	5	6	6	7	8	9
3	1	3	5	8	11	15	18	23	32	1	3	4	4	5	6	6	7	8
4	1	2	5	7	10	13	16	20	28	1	2	3	4	4	5	6	6	7
5	0	2	4	7	9	12	14	18	26	1	2	3	4	4	5	5	6	7
6	0	2	4	6	9	11	13	17	24	1	2	3	3	4	4	5	6	6
7	0	2	4	6	8	10	13	16	23	1	2	3	3	4	4	5	5	6
8	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	5	5	6
9	0	2	4	5	7	9	11	15	20	1	2	3	3	4	4	4	5	6
10	0	2	3	5	7	9	11	14	19	1	2	2	3	3	4	4	5	5
11	0	1	3	4	6	8	9	12	17	1	2	2	3	3	3	4	4	5
12	0	1	2	4	5	6	8	10	14	1	1	2	2	3	3	3	4	4
13	0	1	2	3	4	5	6	7	10	1	1	1	2	2	2	2	3	3
14	0	0	1	1	2	2	3	4	5	0	1	1	1	1	1	1	2	2

(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	1	4	8	13	17	22	27	34	47	2	4	5	6	7	8	9	10	12
3	1	4	7	11	15	19	23	29	40	2	3	5	6	7	7	8	9	11
4	1	3	6	10	13	17	20	26	36	2	3	4	5	6	7	7	8	10
5	1	3	6	9	12	15	18	24	32	2	3	4	5	6	6	7	8	9
6	1	3	5	8	11	14	17	22	30	1	3	4	5	5	6	7	7	9
7	1	3	5	8	10	13	16	21	29	1	3	4	4	5	6	6	7	8
8	1	2	5	7	10	13	15	20	27	1	3	4	4	5	6	6	7	8
9	1	2	5	7	9	12	15	19	26	1	3	3	4	5	5	6	7	8
10	1	2	4	7	9	11	14	18	24	1	2	3	4	5	5	6	6	7
11	0	2	4	6	8	10	13	16	22	1	2	3	4	4	5	5	6	7
12	0	2	3	5	7	9	11	14	20	1	2	3	3	4	4	5	5	6
13	0	1	3	4	6	8	9	12	17	1	2	2	3	3	4	4	5	5
14	0	1	2	3	4	6	7	9	12	1	1	2	2	3	3	3	4	4
15	0	1	1	2	3	3	4	5	7	0	1	1	1	2	2	2	2	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ABLE 9--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 6-MC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

UEL DISTURE	RATE OF SPREAD									FLAME LENGTH								
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	1	5	9	14	19	24	30	38	52	2	5	6	7	9	10	10	12	14
3	1	4	8	12	16	21	26	33	45	2	4	5	7	8	8	9	10	12
4	1	4	7	11	15	18	23	29	40	2	4	5	6	7	8	8	9	11
5	1	3	6	10	13	17	20	26	36	2	3	5	6	6	7	8	9	10
6	1	3	6	9	12	16	19	24	34	2	3	4	5	6	7	7	8	10
7	1	3	6	8	12	15	18	23	32	2	3	4	5	6	7	7	8	9
8	1	3	5	8	11	14	17	22	30	2	3	4	5	6	6	7	8	9
9	1	3	5	8	10	13	16	21	29	2	3	4	5	6	6	7	8	9
10	1	2	5	7	10	13	15	20	27	1	3	4	5	5	6	7	7	8
11	1	2	4	7	9	12	14	19	26	1	3	4	4	5	6	6	7	8
12	0	2	4	6	8	11	13	17	23	1	2	3	4	5	5	6	6	7
13	0	2	4	5	7	9	11	15	20	1	2	3	4	4	5	5	6	7
14	0	1	3	4	6	8	9	12	16	1	2	2	3	3	4	4	5	6
15	0	1	2	3	4	5	6	8	11	1	1	2	2	3	3	3	3	4
16	0	0	1	1	2	2	3	4	5	0	1	1	1	1	1	2	2	2

EL ISTURE	RATE OF SPREAD									FLAME LENGTH								
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	1	5	9	13	18	23	28	36	50	2	4	6	7	8	9	10	11	13
3	1	4	8	12	16	20	24	31	43	2	4	5	6	7	8	9	10	11
4	1	3	7	10	14	18	22	28	38	2	3	5	6	7	7	8	9	10
5	1	3	6	9	13	16	20	25	35	2	3	4	5	6	7	7	8	10
6	1	3	6	9	12	15	18	23	32	2	3	4	5	6	6	7	8	9
7	1	3	5	8	11	14	17	22	30	2	3	4	5	6	6	7	8	9
8	1	3	5	8	11	13	16	21	29	1	3	4	5	5	6	7	7	9
9	1	3	5	7	10	13	16	20	28	1	3	4	5	5	6	6	7	8
10	1	2	5	7	10	12	15	19	26	1	3	4	4	5	6	6	7	8
11	1	2	4	7	9	11	14	18	24	1	3	3	4	5	5	6	7	8
12	0	2	4	6	8	10	12	16	22	1	2	3	4	4	5	5	6	7
13	0	2	3	5	7	9	11	14	19	1	2	3	3	4	4	5	5	6
14	0	1	3	4	5	7	8	11	15	1	2	2	3	3	4	4	4	5
15	0	1	2	3	3	4	5	7	10	1	1	2	2	2	2	3	3	3
16	0	0	1	1	1	2	2	2	3	0	0	1	1	1	1	1	1	1

LE 11--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 8-MC-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

L STURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
CENT	CHAINS PER HOUR									FEET								
2	1	4	8	12	16	21	26	33	45	2	4	5	6	7	8	9	10	11
3	1	4	7	10	14	18	22	28	39	2	3	5	5	6	7	8	9	10
4	1	3	6	9	12	16	19	25	34	2	3	4	5	6	6	7	8	9
5	1	3	5	8	11	14	18	23	31	1	3	4	5	5	6	7	7	9
6	1	3	5	8	11	13	16	21	29	1	3	4	4	5	6	6	7	8
7	1	2	5	7	10	13	16	20	28	1	3	4	4	5	6	6	7	8
8	1	2	5	7	10	12	15	19	26	1	3	3	4	5	5	6	7	8
9	1	2	4	7	9	12	14	18	25	1	2	3	4	5	5	6	6	7
0	0	2	4	6	9	11	13	17	23	1	2	3	4	4	5	5	6	7
1	0	2	4	6	8	10	12	16	21	1	2	3	4	4	5	5	6	7
2	0	2	3	5	7	9	11	14	19	1	2	3	3	4	4	5	5	6
3	0	1	3	4	6	7	9	11	15	1	2	2	3	3	4	4	4	5
4	0	1	2	3	4	5	6	8	11	1	1	2	2	2	3	3	3	4
5	0	0	1	1	2	3	3	4	6	0	1	1	1	1*	1	2	2	2

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orresponds to Photo Series 1-MC-3-PC to 8-MC-3-PC in
xwell and Ward 1979)

BLE 12--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-MC-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	2	3	5	7	9	12	15	21	1	1	2	2	3	3	3	4	4
3	0	1	3	5	6	8	10	13	18	1	1	2	2	2	3	3	3	4
4	0	1	3	4	6	7	9	11	16	1	1	2	2	2	2	3	3	4
5	0	1	2	4	5	7	8	10	14	1	1	1	2	2	2	3	3	3
6	0	1	2	4	5	6	8	10	14	0	1	1	2	2	2	2	3	3
7	0	1	2	3	5	6	7	9	13	0	1	1	2	2	2	2	3	3
8	0	1	2	3	4	6	7	9	12	0	1	1	2	2	2	2	3	3
9	0	1	2	3	4	5	6	8	11	0	1	1	1	2	2	2	2	3
10	0	1	2	3	3	4	5	7	10	0	1	1	1	2	2	2	2	3
11	0	1	1	2	3	4	4	6	8	0	1	1	1	1	1	2	2	2
12	0	0	1	1	2	2	3	4	5	0	0	1	1	1	1	1	1	1
13	0	0	0	0	1	1	1	1	2	0	0	0	0	0	0	0	0	1

TABLE 13--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-MC-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	5	10	15	21	28	34	45	64	2	4	6	8	9	10	11	13	15
3	1	4	8	13	19	24	30	40	57	2	4	6	7	8	9	10	12	14
4	1	4	7	12	17	22	27	36	51	2	4	5	6	7	8	9	11	12
5	1	3	7	11	15	20	24	32	46	2	3	5	6	7	8	9	10	11
6	1	3	6	10	14	18	22	29	42	2	3	4	5	6	7	8	9	10
7	1	3	6	9	13	17	21	27	39	2	3	4	5	6	7	7	8	10
8	1	3	5	8	12	16	19	25	36	1	3	4	5	5	6	7	8	9
9	1	2	5	8	11	15	18	24	34	1	3	3	4	5	6	6	7	8
10	1	2	5	8	11	14	17	23	33	1	2	3	4	5	5	6	7	8
11	1	2	5	7	10	13	17	22	31	1	2	3	4	4	5	5	6	7
12	1	2	4	7	10	13	16	21	30	1	2	3	4	4	5	5	6	7
13	1	2	4	7	10	12	16	20	29	1	2	3	3	4	4	5	5	6
14	0	2	4	7	9	12	15	20	28	1	2	2	3	4	4	4	5	6
15	0	2	4	6	9	11	14	19	27	1	2	2	3	3	4	4	5	6
16	0	2	4	6	8	11	14	18	25	1	2	2	3	3	3	4	4	5
17	0	2	4	6	8	10	13	17	24	1	1	2	2	3	3	3	4	5
18	0	2	3	5	7	9	12	16	22	1	1	2	2	2	3	3	4	4
19	0	1	3	5	7	9	11	14	20	1	1	2	2	2	2	3	3	4
20	0	1	3	4	6	8	10	12	18	0	1	1	2	2	2	2	3	3
21	0	1	2	4	5	6	8	11	15	0	1	1	1	2	2	2	2	3
22	0	1	2	3	4	5	6	8	12	0	1	1	1	1	1	2	2	2
23	0	1	1	2	3	4	5	6	8	0	0	1	1	1	1	1	1	1
24	0	0	1	1	1	2	2	3	4	0	0	0	0	0	1	1	1	1

TABLE 14--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-MC-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	5	8	11	14	17	22	30	1	2	3	4	4	5	5	6	7
3	0	2	4	7	9	12	14	19	26	1	2	3	3	4	4	5	5	6
4	0	2	4	6	8	10	13	16	23	1	2	2	3	3	4	4	5	6
5	0	2	4	5	7	10	12	15	21	1	2	2	3	3	4	4	5	5
6	0	2	3	5	7	9	11	14	20	1	2	2	3	3	4	4	4	5
7	0	2	3	5	7	9	10	13	19	1	2	2	3	3	3	4	4	5
8	0	2	3	5	6	8	10	13	18	1	2	2	3	3	3	4	4	5
9	0	1	3	4	6	8	9	12	16	1	1	2	2	3	3	3	4	4
10	0	1	3	4	5	7	8	11	15	1	1	2	2	3	3	3	4	4
11	0	1	2	3	5	6	7	9	13	1	1	2	2	2	3	3	3	4
12	0	1	2	3	4	4	6	7	10	0	1	1	2	2	2	2	2	3
13	0	1	1	2	2	3	3	4	6	0	1	1	1	1	1	1	2	2
14	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0

(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	1	3	6	10	13	17	20	26	36	1	3	4	5	5	6	7	7	9
3	1	3	5	8	11	14	17	22	31	1	3	3	4	5	5	6	7	8
4	1	2	5	7	10	13	15	20	27	1	2	3	4	4	5	5	6	7
5	0	2	4	7	9	12	14	18	25	1	2	3	4	4	5	5	6	7
6	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	5	5	6
7	0	2	4	6	8	10	13	16	22	1	2	3	3	4	4	5	5	6
8	0	2	4	6	8	10	12	15	21	1	2	3	3	4	4	5	5	6
9	0	2	3	5	7	9	11	14	20	1	2	3	3	4	4	4	5	6
10	0	2	3	5	7	8	10	13	18	1	2	2	3	3	4	4	5	5
11	0	1	3	4	6	7	9	12	16	1	2	2	3	3	3	4	4	5
12	0	1	2	4	5	6	8	10	13	1	1	2	2	3	3	3	4	4
13	0	1	2	3	3	4	5	7	10	0	1	1	2	2	2	2	3	3
14	0	0	1	1	2	2	3	3	5	0	1	1	1	1	1	1	1	2

BLE 16--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-MC-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFDR MODELS)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	1	5	10	15	22	28	35	46	66	2	4	6	7	9	10	11	12	14
3	1	4	9	14	19	25	31	41	58	2	4	5	7	8	9	10	11	13
4	1	4	8	12	17	22	28	37	52	2	4	5	6	7	8	9	10	12
5	1	3	7	11	15	20	25	33	47	2	3	5	6	7	7	8	9	11
6	1	3	6	10	14	18	23	30	43	2	3	4	5	6	7	8	9	10
7	1	3	6	9	13	17	21	28	40	1	3	4	5	6	6	7	8	9
8	1	3	6	9	12	16	20	26	37	1	3	4	4	5	6	7	7	9
9	1	3	5	8	12	15	19	25	35	1	2	3	4	5	5	6	7	8
10	1	2	5	8	11	14	18	24	34	1	2	3	4	5	5	6	6	8
11	1	2	5	8	11	14	17	23	32	1	2	3	4	4	5	5	6	7
12	1	2	5	7	10	13	17	22	31	1	2	3	3	4	4	5	6	7
13	1	2	4	7	10	13	16	21	30	1	2	3	3	4	4	5	5	6
14	1	2	4	7	9	12	15	20	29	1	2	2	3	3	4	4	5	6
15	0	2	4	6	9	12	15	19	27	1	2	2	3	3	4	4	5	5
16	0	2	4	6	9	11	14	18	26	1	1	2	3	3	3	4	4	5
17	0	2	4	6	8	11	13	17	25	1	1	2	2	3	3	3	4	4
18	0	2	3	5	7	10	12	16	23	1	1	2	2	2	3	3	3	4
19	0	1	3	5	7	9	11	15	21	1	1	1	2	2	2	3	3	4
20	0	1	3	4	6	8	10	13	18	0	1	1	2	2	2	2	3	3
21	0	1	2	4	5	7	8	11	15	0	1	1	1	2	2	2	2	3
22	0	1	2	3	4	5	7	9	12	0	1	1	1	1	1	1	2	2
23	0	1	1	2	3	4	5	6	9	0	0	1	1	1	1	1	1	1

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	0	2	4	7	9	12	15	19	26	1	2	3	3	4	4	4	5	6
3	0	2	4	6	8	10	12	16	22	1	2	2	3	3	4	4	4	5
4	0	2	3	5	7	9	11	14	20	1	2	2	3	3	3	4	4	5
5	0	2	3	5	6	8	10	13	18	1	1	2	2	3	3	3	4	4
6	0	1	3	4	6	8	10	12	17	1	1	2	2	3	3	3	4	4
7	0	1	3	4	6	7	9	12	16	1	1	2	2	3	3	3	4	4
8	0	1	3	4	5	7	9	11	15	1	1	2	2	2	3	3	3	4
9	0	1	2	4	5	6	8	10	14	1	1	2	2	2	3	3	3	4
10	0	1	2	3	5	6	7	9	13	1	1	2	2	2	2	3	3	3
11	0	1	2	3	4	5	6	8	11	0	1	1	2	2	2	2	3	3
12	0	1	1	2	3	4	4	6	8	0	1	1	1	1	2	2	2	2
13	0	0	1	1	1	2	2	3	4	0	0	1	1	1	1	1	1	1

LE 18--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 7-MC-3-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

L STURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
CENT	CHAINS PER HOUR									FEET								
2	1	4	9	13	18	23	28	35	49	2	4	6	7	8	9	10	11	13
3	1	4	7	11	15	20	24	31	42	2	4	5	6	7	8	9	10	11
4	1	3	7	10	14	17	21	27	37	2	3	5	6	6	7	8	9	10
5	1	3	6	9	12	16	19	25	34	2	3	4	5	6	7	7	8	9
6	1	3	6	8	11	15	18	23	31	2	3	4	5	6	6	7	8	9
7	1	3	5	8	11	14	17	22	30	1	3	4	5	5	6	7	7	9
8	1	3	5	8	10	13	16	21	28	1	3	4	5	5	6	6	7	8
9	1	2	5	7	10	13	15	20	27	1	3	4	4	5	6	6	7	8
0	1	2	4	7	9	12	14	19	26	1	3	4	4	5	5	6	7	8
1	0	2	4	6	9	11	13	17	24	1	2	3	4	5	5	6	6	7
2	0	2	4	6	8	10	12	15	21	1	2	3	4	4	5	5	6	7
3	0	2	3	5	7	8	10	13	18	1	2	3	3	4	4	5	5	6
4	0	1	2	4	5	6	8	10	14	1	2	2	3	3	3	4	4	5
5	0	1	2	2	3	4	5	6	9	1	1	1	2	2	2	2	3	3
6	0	0	0	1	1	1	1	2	2	0	0	0	0	1	1	1	1	1

L STURE	RATE OF SPREAD									FLAME LENGTH									
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)									
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
CENT	CHAINS PER HOUR									FEET									
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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well and Ward 1979)

EL STURE	RATE OF SPREAD									FLAME LENGTH									
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)									
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET									
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BLE 21--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 2-TF-4-RC

EL STURE	RATE OF SPREAD									FLAME LENGTH								
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
CENT	CHAINS PER HOUR									FEET								
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SLASH MODEL)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	1	2	3	4	5	6	7	10	1	2	2	3	3	4	4	4	5
3	0	1	2	2	3	4	5	6	9	1	1	2	2	3	3	3	4	5
4	0	1	1	2	3	4	4	6	8	1	1	2	2	3	3	3	4	4
5	0	1	1	2	3	3	4	5	7	1	1	2	2	2	3	3	3	4
6	0	1	1	2	2	3	4	5	7	1	1	2	2	2	3	3	3	4
7	0	1	1	2	2	3	4	5	6	1	1	2	2	2	2	3	3	4
8	0	1	1	2	2	3	3	4	6	1	1	2	2	2	2	3	3	3
9	0	1	1	2	2	3	3	4	6	1	1	1	2	2	2	3	3	3
10	0	0	1	1	2	2	3	4	5	1	1	1	2	2	2	2	3	3
11	0	0	1	1	2	2	3	3	5	0	1	1	2	2	2	2	3	3
12	0	0	1	1	1	2	2	3	4	0	1	1	1	2	2	2	2	3
13	0	0	1	1	1	1	2	2	3	0	1	1	1	1	1	2	2	2
14	0	0	0	1	1	1	1	1	2	0	0	1	1	1	1	1	1	1
15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

BLE 23--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 4-TF-4-RC
(RATE OF SPREAD ESTIMATES ARE ONE-HALF OF NFFL CONTINUOUS SLASH MODEL)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	2	3	5	7	9	11	14	20	1	2	3	4	4	5	5	6	7
3	0	2	3	5	6	8	10	12	17	1	2	3	3	4	4	5	5	6
4	0	1	3	4	5	7	9	11	15	1	2	3	3	4	4	4	5	6
5	0	1	2	4	5	6	8	10	14	1	2	2	3	3	4	4	5	5
6	0	1	2	3	5	6	7	9	13	1	2	2	3	3	4	4	4	5
7	0	1	2	3	4	6	7	9	12	1	2	2	3	3	3	4	4	5
8	0	1	2	3	4	5	7	8	12	1	2	2	3	3	3	4	4	5
9	0	1	2	3	4	5	6	8	11	1	1	2	2	3	3	3	4	5
10	0	1	2	3	4	5	6	7	10	1	1	2	2	3	3	3	4	4
11	0	1	2	2	3	4	5	7	9	1	1	2	2	2	3	3	3	4
12	0	1	1	2	3	4	4	6	8	1	1	2	2	2	2	3	3	3
13	0	1	1	2	2	3	3	4	6	0	1	1	1	2	2	2	2	3
14	0	0	1	1	1	2	2	3	4	0	1	1	1	1	1	1	2	2
15	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	2	5	7	10	12	15	19	27	1	2	3	3	4	4	5	5	6
3	0	2	4	6	8	11	13	17	23	1	2	2	3	3	4	4	5	5
4	0	2	3	5	7	9	11	15	20	1	2	2	3	3	3	4	4	5
5	0	2	3	5	7	9	10	13	19	1	1	2	2	3	3	4	4	5
6	0	2	3	5	6	8	10	13	18	1	1	2	2	3	3	3	4	4
7	0	1	3	4	6	8	9	12	17	1	1	2	2	3	3	3	4	4
8	0	1	3	4	6	7	9	11	16	1	1	2	2	3	3	3	4	4
9	0	1	3	4	5	7	8	11	15	1	1	2	2	2	3	3	3	4
10	0	1	2	3	5	6	7	9	13	1	1	2	2	2	2	3	3	4
11	0	1	2	3	4	5	6	8	11	0	1	1	2	2	2	2	3	3
12	0	1	1	2	3	4	5	6	8	0	1	1	1	1	2	2	2	2
13	0	0	1	1	2	2	2	3	4	0	0	1	1	1	1	1	1	1

LE 25--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 6-TF-4-RC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

TURE	RATE OF SPREAD									FLAME LENGTH								
	EFFECTIVE MIDFLAME WIND (MI/H)									EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ENT	CHAINS PER HOUR									FEET								
	1	4	8	12	16	21	25	33	45	2	4	5	6	7	8	9	10	11
	1	3	7	10	14	18	22	28	39	2	3	4	5	6	7	8	9	10
	1	3	6	9	12	16	19	25	34	2	3	4	5	6	6	7	8	9
	1	3	5	8	11	14	18	23	31	1	3	4	5	5	6	7	7	8
	1	3	5	8	11	13	16	21	29	1	3	4	4	5	6	6	7	8
	1	2	5	7	10	13	16	20	27	1	3	4	4	5	5	6	7	8
	1	2	5	7	9	12	15	19	26	1	3	3	4	5	5	6	7	8
	1	2	4	7	9	12	14	18	25	1	2	3	4	5	5	6	6	7
	0	2	4	6	8	11	13	17	23	1	2	3	4	4	5	5	6	7
	0	2	4	6	8	10	12	15	21	1	2	3	4	4	5	5	6	7
	0	2	3	5	7	9	11	14	19	1	2	3	3	4	4	5	5	6
	0	1	3	4	6	7	9	11	15	1	2	2	3	3	3	4	4	5
	0	1	2	3	4	5	6	8	11	1	1	2	2	2	3	3	3	4
	0	0	1	1	2	2	3	4	5	0	1	1	1	1	1	1	2	2

ue Fir

ze Class 4

rtial Cut

bles 26 Through 30

rresponds to Photo Series 1-TF-4-PC to 5-TF-4-PC in
well and Ward 1979)

TABLE 26--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 1-TF-4-PC
(RATE OF SPREAD ESTIMATES ARE ONE-HALF OF NFFL CONTINUOUS SLASH MODEL)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	0	1	3	4	5	7	8	11	15	1	2	2	3	3	3	4	4	5
3	0	1	2	3	5	6	7	9	13	1	1	2	2	3	3	3	4	4
4	0	1	2	3	4	5	6	8	11	1	1	2	2	2	3	3	3	4
5	0	1	2	3	4	5	6	7	10	1	1	2	2	2	3	3	3	4
6	0	1	2	3	3	4	5	7	10	1	1	2	2	2	2	3	3	4
7	0	1	2	2	3	4	5	7	9	1	1	2	2	2	2	3	3	3
8	0	1	1	2	3	4	5	6	9	1	1	1	2	2	2	3	3	3
9	0	1	1	2	3	4	5	6	8	0	1	1	2	2	2	2	3	3
10	0	1	1	2	3	3	4	5	7	0	1	1	2	2	2	2	2	3
11	0	1	1	2	2	3	4	5	6	0	1	1	1	2	2	2	2	3
12	0	0	1	1	2	2	3	3	5	0	1	1	1	1	1	2	2	2
13	0	0	0	1	1	1	2	2	3	0	0	1	1	1	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

EL ISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
RCENT	CHAINS PER HOUR									FEET								
2	0	2	4	7	9	12	14	18	26	1	2	3	3	4	4	4	5	6
3	0	2	4	6	8	10	12	16	22	1	2	2	3	3	4	4	4	5
4	0	2	3	5	7	9	11	14	19	1	1	2	2	3	3	4	4	5
5	0	2	3	5	6	8	10	13	18	1	1	2	2	3	3	3	4	4
6	0	1	3	4	6	8	9	12	17	1	1	2	2	3	3	3	4	4
7	0	1	3	4	6	7	9	11	16	1	1	2	2	3	3	3	3	4
8	0	1	3	4	5	7	8	11	15	1	1	2	2	2	3	3	3	4
9	0	1	2	4	5	6	8	10	14	1	1	2	2	2	3	3	3	4
0	0	1	2	3	4	6	7	9	12	1	1	1	2	2	2	3	3	3
1	0	1	2	3	4	5	6	7	10	0	1	1	2	2	2	2	2	3
2	0	1	1	2	3	3	4	5	7	0	1	1	1	1	2	2	2	2
3	0	0	1	1	1	2	2	3	4	0	0	1	1	1	1	1	1	1

TABLE 28--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 3-TF-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	3	7	10	14	17	21	27	38	2	3	4	5	6	6	7	8	9
3	1	3	6	9	12	15	18	23	32	1	3	4	4	5	6	6	7	8
4	1	3	5	8	10	13	16	21	29	1	2	3	4	5	5	6	6	7
5	1	2	5	7	9	12	15	19	26	1	2	3	4	4	5	5	6	7
6	0	2	4	6	9	11	14	18	24	1	2	3	4	4	5	5	6	7
7	0	2	4	6	8	11	13	17	23	1	2	3	3	4	4	5	5	6
8	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	5	5	6
9	0	2	4	6	8	10	12	15	21	1	2	3	3	4	4	5	5	6
10	0	2	3	5	7	9	11	14	19	1	2	3	3	4	4	4	5	6
11	0	2	3	5	6	8	10	12	17	1	2	2	3	3	4	4	4	5
12	0	1	2	4	5	7	8	10	14	1	1	2	2	3	3	3	4	4
13	0	1	2	3	4	5	6	8	11	1	1	1	2	2	2	3	3	3
14	0	1	1	2	2	3	3	4	6	0	1	1	1	1	1	1	2	2

UEL DISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
ERCENT	CHAINS PER HOUR									FEET								
2	1	4	8	12	15	21	25	32	45	2	4	5	6	7	8	9	10	11
3	1	3	7	10	14	18	22	28	38	2	3	4	5	6	7	8	9	10
4	1	3	6	9	12	16	19	25	34	2	3	4	5	6	6	7	8	9
5	1	3	5	8	11	14	18	22	31	1	3	4	5	5	6	7	7	8
6	1	3	5	8	10	13	16	21	29	1	3	4	4	5	6	6	7	8
7	1	2	5	7	10	13	15	20	27	1	3	3	4	5	5	6	7	8
8	1	2	5	7	9	12	15	19	26	1	2	3	4	5	5	6	7	8
9	1	2	4	7	9	11	14	18	25	1	2	3	4	5	5	6	6	7
10	0	2	4	6	8	11	13	17	23	1	2	3	4	4	5	5	6	7
11	0	2	4	6	8	10	12	16	21	1	2	3	4	4	5	5	6	7
12	0	2	3	5	7	9	11	13	19	1	2	3	3	4	4	5	5	6
13	0	1	3	4	5	7	9	11	15	1	2	2	3	3	3	4	4	5
14	0	1	2	3	4	5	6	8	11	1	1	2	2	2	3	3	3	4
15	0	0	1	1	2	2	3	4	5	0	1	1	1	1	1	1	2	2

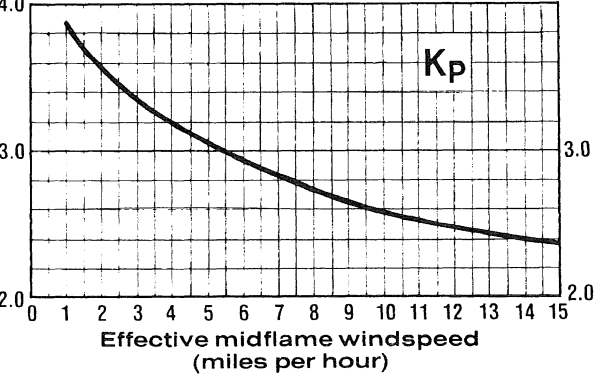
TABLE 30--FIRE BEHAVIOR AND CONTROL INFORMATION FOR PHOTO 5-TF-4-PC
(FIRE BEHAVIOR INFORMATION SCALED FROM NFFL MODELS)

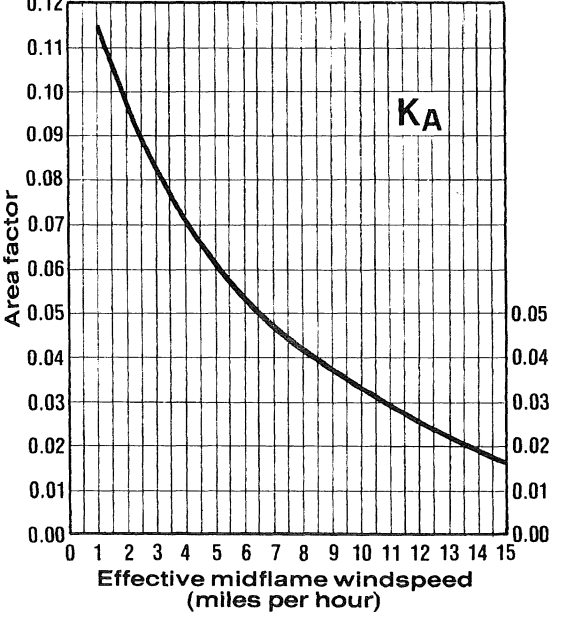
FUEL MOISTURE	RATE OF SPREAD — EFFECTIVE MIDFLAME WIND (MI/H)									FLAME LENGTH — EFFECTIVE MIDFLAME WIND (MI/H)								
	0	2	4	6	8	10	12	14	16	0	2	4	6	8	10	12	14	16
PERCENT	CHAINS PER HOUR									FEET								
2	1	4	7	10	14	18	22	29	39	2	3	4	5	6	7	7	8	10
3	1	3	6	9	12	16	19	24	34	1	3	4	5	5	6	7	7	9
4	1	3	5	8	11	14	17	22	30	1	3	3	4	5	5	6	7	8
5	1	2	5	7	10	13	15	20	27	1	2	3	4	5	5	6	6	7
6	1	2	4	7	9	12	14	18	26	1	2	3	4	4	5	5	6	7
7	0	2	4	6	9	11	14	18	24	1	2	3	4	4	5	5	6	7
8	0	2	4	6	8	11	13	17	23	1	2	3	4	4	5	5	6	7
9	0	2	4	6	8	10	12	16	22	1	2	3	3	4	4	5	5	6
10	0	2	4	5	7	9	11	15	20	1	2	3	3	4	4	5	5	6
11	0	2	3	5	7	8	10	13	18	1	2	2	3	3	4	4	5	5
12	0	1	3	4	6	7	9	11	15	1	2	2	3	3	3	4	4	5
13	0	1	2	3	4	5	7	8	12	1	1	2	2	2	3	3	3	4
14	0	1	1	2	3	3	4	5	7	0	1	1	1	1	2	2	2	2
15	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0

Appendix 1

Fire Perimeter and Area Calculation Graphs and Formulas

(Adapted from Fire Behavior Officer's Field Reference, National Interagency Fire Training Center, Marana, Arizona)





= Perimeter (chains)

$= K_P D$

$= K_P(RxT)$

= Area (acres)

$= K_A D^2$

$= K_A(RxT)^2$

WHERE:

K_P = Perimeter factor
R = Rate of spread (chains per hour)
T = Time (hour); 1-hour maximum
K_A = Area factor
D = R x T; spread distance (chains)

Appendix 2

Resistance to control ratings, flame length adjustment factor, slope adjustment factor, and conversion of resistance to control rating values to chains per hour of line constructed by one person

ctor (table 32) times slope adjustment factor (table 33) equals the adjusted
ting. Use table 34 to convert adjusted rating to actual resistance to
ntrol.

le 31--Fuel resistance to control ratings by photo number[1]

TO NUMBER	RATING	PHOTO NUMBER	RATING
C-4-RC	4	1-TF-4-RC	1
C-4-RC	11	2-TF-4-RC	2
C-4-RC	30	3-TF-4-RC	9
		4-TF-4-RC	11
C-4-PC	2	5-TF-4-RC	6
C-4-PC	12	6-TF-4-RC	17
C-4-PC	5		
C-4-PC	10	1-TF-4-PC	4
C-4-PC	13	2-TF-4-PC	7
C-4-PC	17	3-TF-4-PC	8
C-4-PC	20	4-TF-4-PC	17
C-4-PC	17	5-TF-4-PC	27
C-3-PC	2		
C-3-PC	6		
C-3-PC	5		
C-3-PC	6		
C-3-PC	7		
C-3-PC	9		
C-3-PC	13		
C-3-PC	8		

tings derived from matrix by Wayne G. Maxwell (on file at Pacific
hwest Forest and Range Experiment Station, Portland, Oregon).

ble 32--Flame length adjustment factor

lame length (feet)	0-4	5-8	9-12	13+
djustment factor	1	1.5	2.0	3.0

ble 33--Slope adjustment factor

lope (percent)	0-30	31-60	61-75	75+
djustment factor	1	1.2	1.5	1.9

our of line constructed by 1 person

djusted ating alues	Chains per hour	Adjusted rating values	Chains per hour
1	12.00	13	0.92
2	6.00	14	.86
3	4.00	15	.80
4	3.00	16	.75
5	2.40	17	.71
6	2.00	18	.67
7	1.70	19	.63
8	1.50	20	.60
9	1.30	25	.48
0	1.20	30	.40
1	1.10	35	.34
2	1.00	40	.30

GPO 797-498

The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

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